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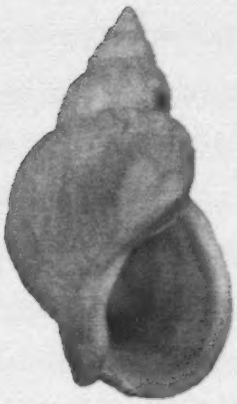
Canadian Science Advisory Secretariat
Science Advisory Report 2015/032

Quebec Region

ASSESSMENT OF QUEBEC COASTAL WATERS WHELK STOCKS IN 2014



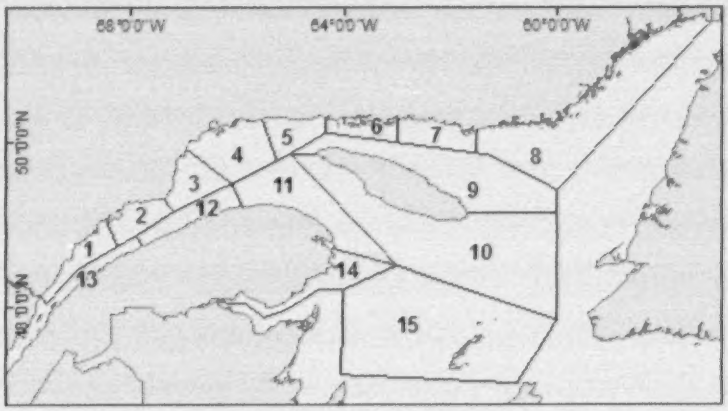


Figure 1: Whelk fishing areas in Quebec.

Source: DFO 2009

Context

The commercial whelk fishery began in the Estuary and Gulf of St. Lawrence in the 1940s. It expanded to the North Shore in the early 1990s and to the Îles-de-la-Madeleine in 2003. It has been more intensive in the Gaspé Peninsula–Lower St. Lawrence area since 2005. The whelk fishery is an inshore fishery, and it mainly uses cone-shaped traps. It focuses primarily on Buccinum undatum, although some other species of Buccinum are present in the Estuary and Gulf of St. Lawrence. The fishery is regulated in all areas as to the number of licences, the number of traps and the minimum legal size of 70 mm. Quotas on landings are in place in Areas 1, 2, 11, 12, 13 and 15.

The resource is assessed every three years, and the last whelk stock assessment took place in winter 2012. The main indicators used for monitoring stocks are landings, fishing effort, catch per unit effort (CPUE) and size structure.

This science advisory report is from the March 10, 2015, meeting on the Assessment of the whelk fishery in the Quebec's inshore waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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SUMMARY

- In 2014, whelk landings totalled 951 t in Quebec. A total of 87% of these landings were from the North Shore, 12% from the Gaspé Peninsula–Lower St. Lawrence and 2% from the Îles-de-la-Madeleine. Landings decreased in most fishing areas compared to 2011, and total allowable catches (TACs), when present, were not attained.
- In 2013 and 2014, the CPUE was above the reference average (from the 2001-2013 period) in Areas 1, 4 and 13, near average in Areas 2, 5, 6 and 8 and below average in Areas 3, 7, 12 and 15. In the latter four areas, the CPUE measured in 2014 was one of the lowest since 2001.
- Since 2011, average sizes have been fairly stable in all areas. In 2014 landings, the proportion of whelk smaller than the minimum legal size of 70 mm was less than 4%, except in areas 1 (10%) and 8 (19%). According to our data, the average size at which 50% of females are mature varies from 65 to 80 mm depending on the area. Harvesting immature individuals should be avoided.
- Area 10 is not fished, and fishing effort has been sporadic and low in Areas 9, 11 and 14. It is therefore impossible to comment on the status of the resource in these areas.
- In the period from 2012 to 2014, stock status indicators (CPUE and size structure) showed a positive trend in Areas 1, 4 and 13, were stable in Areas 2, 5, 6 and 8 and decreased in Areas 3 and 7. In Areas 12 and 15, the 2014 CPUE was very low. The considerable drop in CPUE in Area 15 was not anticipated given the performance of the fishery in 2013 and could be related to the atypical environmental conditions in summer 2014.
- In Areas 3, 4, 5, 8, 12 and 13, the number of traps used in 2014 was between 20 and 41% of the authorized number of traps under the current management measures. These various stocks may not be able to support the deployment of latent effort, especially in areas that are already fished in entirety.

BACKGROUND

The Waved Whelk, *Buccinum undatum*, is a gastropod mollusc found along the western Atlantic coast from New Jersey to Labrador, including the Estuary and Gulf of St. Lawrence. It is common in cold waters from the subtidal area (below the low water boundary) to depths of 30 metres or more. Whelk is a necrophagous predator. It feeds mainly on invertebrates such as polychaetes, molluscs and echinoderms. According to the literature, its life span is approximately 15 years. In the St. Lawrence, it can reach a shell height of 120-130 mm. Whelk can move quite fast (15 cm/min), covering several dozen metres when food or predators are present.

The sexes are separate. According to data collected in 2013 in three areas on the Upper North Shore (Areas 1 and 2) and the Îles-de-la-Madeleine, the sex ratio varies depending on the size of the whelk and the site. The sex ratio is fairly equal for whelk from 35 to 89 mm, but favours females in individuals ≥ 90 mm. Whelk ≥ 80 mm also have a high level of parasitism, between 34 and 46%, except for Baie-Comeau (Area 2), where it is 4%. The parasite, likely the castrating trematode *Neophasis sp.*, destroys the gonads, reducing the reproductive potential of this size class. The average size at which 50% of individuals reach sexual maturity varies depending on the sex and fishing area. It is generally greater for females. Our data show that the average size at maturity (minimum–maximum) for all fishing areas studied is 68.8 mm (58-80 mm) for males and 72.6 mm (65-80 mm) for females.

Whelk fertilization takes place internally. On the North Shore and the Gaspé Peninsula, the mating season occurs in May and June. The eggs are laid two to three weeks after mating, mostly in June and July. Egg-laying is generally collective; females assemble to lay eggs on one site. Eggs are enclosed in chitin capsules that are clumped together in a mass of several centimetres and attached to the

substrate. There is no planktonic larval stage. In the Estuary and Northern Gulf of St. Lawrence, juveniles emerge from the capsules after five to eight months of development (November to February) and are about 2-3 mm in size.

Whelk growth is fairly slow, and in Quebec the minimum legal size is reached after 6-7 years. Adults lead a rather sedentary life. They spend most of their time immobile and half buried in sediments. Evidence suggests that this behaviour, together with the absence of a larval phase, limits exchanges with adjoining populations and the possibility of rapidly recolonizing overexploited sites.

ASSESSMENT

There are 15 whelk management areas in Quebec waters. Areas 1 to 8 are along the North Shore, Areas 9 and 10 along Anticosti Island, Areas 11 to 14 along the Lower St. Lawrence and the Gaspé Peninsula, and Area 15 along the Îles-de-la-Madeleine (Figure 1). Area 10 has not been fished since 1997, and only certain fishers have fished for a few days in Areas 9, 11 and 14 in recent years. It is therefore impossible to determine the status of the resource in these areas. In recent years, there have regularly been less than five active fishers in Areas 2, 3 and 7, and occasionally in Areas 4, 5 and 13.

In 2014, there were 249 whelk licence holders in Quebec; however, only 69 of them were active (Table 1). Between 50 and 175 traps are authorized per licence. The total number of authorized traps for all licences in each fishing area varies between 550 and 6,400 traps, while the number of used or active traps is low, with 300 to 1,300 traps per fishing area. In 2014, the proportion of active traps was between 20 and 64% depending on the fishing area.

Table 1: Number of active licences, total number of licences issued, number of active traps, total number of traps authorized and percentage of active traps per fishing area in 2014.

	Fishing Area										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**13**	**15**
Active licences	6	3	3	6	4	9	3	13	9	4	7
Licences issued	11	6	7	28	20	15	7	64	37	13	11
Active traps	750	300	350	700	550	850	400	1,300	950	350	700
Authorized traps	1,300	550	850	2,559	1,900	1,300	600	6,400	2,950	1,075	1,100
Percentage of active traps [1]	58%	55%	41%	27%	29%	65%	67%	20%	32%	33%	64%

[1] = number of active traps / total number of authorized traps x 100%.

Since 2005, the minimum legal size has been 70 mm everywhere in Quebec. The fishing season, which lasts six months in all fishing areas, extends from April or May to October or November. In Areas 1 and 2 on the North Shore, TACs of 491 and 109 t respectively were implemented in 2003. In the Gaspé Peninsula–Lower St. Lawrence, there have been TACs in Areas 11, 12 and 13 since 2010. They were set at 32, 135 and 82 t respectively over the past three years. In the Îles-de-la-Madeleine (Area 15), there has been a TAC since 2003, and it was 376 t from 2012 to 2014. None of the TACs were reached in 2014.

Whelk landings in Quebec peaked at 2,000 t live weight in 2003, when the fishery was introduced in the Îles-de-la-Madeleine (Figure 2). Subsequently, landings decreased, especially on the North Shore. Since 2006, landings have varied between 951 and 1,587 t (Table 1). In 2014, they were 951 t and 87% of them were from the North Shore, 12% from the Gaspé Peninsula–Lower St. Lawrence and 2% from the Îles-de-la-Madeleine. That same year, landings dropped by 24% on the North Shore, 25% in the Gaspé Peninsula–Lower St. Lawrence and 94% in the Îles-de-la-Madeleine compared to their respective reference averages. In most fishing areas, 2014 landings were also lower than in 2011, the last assessment year.

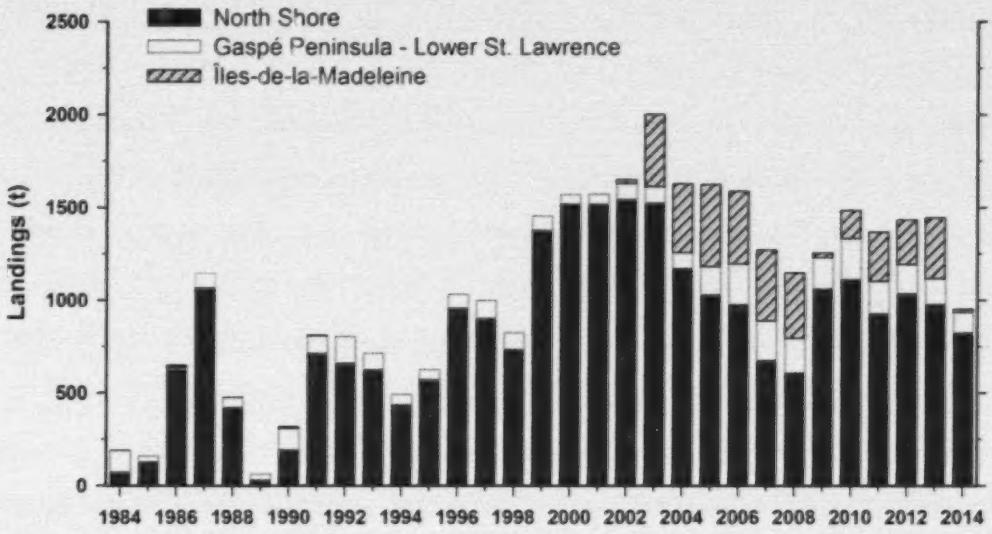

Figure 2: Whelk landings by region from 1987 to 2014.

Fishing effort reached a maximum value of 385,800 trap hauls in 2003 (Table 2). Effort then decreased, reaching 206,200 trap hauls in 2008. Effort has since varied between 173,100 and 261,900 trap hauls per year. In 2014, there were 173,100 trap hauls, a decrease in effort of 37% for the North Shore, 24% for the Gaspé Peninsula–Lower St. Lawrence and 79% for the Îles-de-la-Madeleine compared with their respective reference averages. The variations in landings by fishing area since 2006 are largely due to changes in fishing effort.

The average CPUE calculated based on logbooks is different in the different fishing areas (Table 4). Until recently, the highest CPUE was observed in the Îles-de-la-Madeleine, with a reference average (2003-2013) of 20.3 kg/trap. Elsewhere in Quebec, the average CPUE (2001-2013) is below 10.5 kg/trap. In 2013 and 2014, CPUE was above the reference average in areas 1, 4 and 13, near average in Areas 2, 5, 6 and 8 and below average in Areas 3, 7, 12 and 15. In the latter four areas, the CPUE measured in 2014 was one of the lowest since 2001.

Since 2004, DFO's commercial sampling program has provided information on the size (shell height) of landed whelk. Since 2006, the average size of landed whelk has remained stable or increased slightly (Table 5). In 2014, it was between 75 and 95 mm depending on the fishing area and was similar to or above its respective area reference averages. Since 2007, the percentage of landed whelk below the minimum legal size of 70 mm has generally been below 10% (Table 6). In 2014, the percentage of undersized whelk landed was below 4%, except in Areas 1 (10%) and 8 (19%). In Area 8, the percentage of undersized whelk landed has been the highest of all areas since 2009.

A research survey has been conducted every two years since 2005 in the Forestville, Pointe-aux-Outardes and Baie-Comeau sectors on the Upper North Shore (Areas 1 and 2). The surveys are conducted using a Digby scallop dredge and the four baskets are lined with 19-mm Vexar™ netting. More than 99% of the whelk harvested belong to the *Buccinum undatum* species. Only a few *B. glaciale*, *B. scalariforme*, *B. totteni* and *Buccinum sp.* individuals have been found during the surveys. In 2013, the relative density of whelk ≥ 20 mm (for all species of *Buccinum*) was from 0.1 to 135.6 individuals/100 m^2 depending on the site.

Table 2: Whelk landings (t) by fishing area and for all of Quebec from 2000 to 2014.

Year	Fishing Area											Quebec [1]
	1	2	3	4	5	6	7	8	12	13	15	
2000	550	cd[2]	cd	108	401	184	cd	37	cd	cd	0	1,571
2001	589	157	cd	162	359	201	cd	cd	cd	cd	0	1,573
2002	594	132	cd	143	310	243	cd	6	32	23	cd	1,649
2003	408	cd	cd	149	385	282	cd	90	34	cd	388	2,000
2004	204	71	39	161	322	279	cd	7	39	cd	369	1,628
2005	202	72	cd	114	272	193	cd	63	84	24	442	1,623
2006	247	cd	28	107	221	196	cd	47	150	cd	392	1,587
2007	151	cd	14	83	168	152	cd	21	127	77	382	1,269
2008	118	cd	cd	48	146	216	cd	24	117	67	352	1,147
2009	300	cd	cd	51	274	330	cd	11	110	57	cd	1,255
2010	204	cd	cd	60	363	358	cd	38	129	91	150	1,484
2011	132	cd	cd	42	312	314	cd	21	95	78	265	1,368
2012	114	cd	cd	64	409	296	cd	27	75	cd	239	1,432
2013	241	cd	cd	82	250	280	cd	36	70	66	327	1,445
2014	290	cd	cd	cd	cd	270	cd	23	46	cd	15	951
Average [3]	269	70	22	97	292	257	52	30	82	51	258	1,497
Variation [4]	8%					5%		-23%	-45%		-94%	-36%

[1] = Total for all fishing areas in Quebec.
[2] = cd: confidential data (four or fewer fishers).
[3] = 2001–2013 reference average, except for Area 15, where the 2003–2013 average was calculated.
[4] = Variation between the 2014 value and the reference average.

Table 3: Fishing effort (trap haul x 10^2) by fishing area and for all of Quebec from 2002 to 2014.

Year	Fishing Area											Quebec [1]
	1	2	3	4	5	6	7	8	12	13	15	
2002	507	147	cd[2]	472	885	479	cd	15	117	53	cd	2,937
2003	433	cd	cd	547	1,097	711	cd	262	125	cd	155	3,858
2004	297	81	68	533	1,062	891	cd	20	131	cd	185	3,563
2005	277	105	cd	414	854	758	cd	143	266	55	192	3,409
2006	319	cd	49	354	658	646	cd	150	369	cd	172	3,052
2007	223	cd	30	246	538	472	cd	53	324	124	178	2,317
2008	153	cd	cd	164	409	569	cd	75	303	109	164	2,062
2009	331	cd	cd	149	622	643	cd	23	272	85	cd	2,291
2010	288	cd	cd	207	758	643	cd	131	279	101	65	2,619
2011	195	cd	cd	106	547	634	cd	67	215	88	136	2,147
2012	136	cd	cd	157	799	675	cd	79	199	cd	119	2,449
2013	217	cd	cd	190	625	610	cd	87	180	90	172	2,306
2014	277	cd	cd	cd	cd	553	cd	69	189	cd	27	1,731
Avg. [3]	281	69	36	295	738	644	84	92	232	85	130	2,751
Var. [4]	-2%					-14%		-25%	-18%		-79%	-37%

[1] = Total for all fishing areas.
[2] = cd: confidential data (four or fewer fishers).
[3] = 2002-2013 reference average, except for Area 15, where the 2003-2013 average was calculated.
[4] = Variation between the 2014 value and the reference average.

Table 4: Standardized whelk catches per unit effort (kg of live weight/trap) by fishing area from 2001 to 2014 based on logbooks.

Year	Fishing Area										
	1	2	3	4	5	6	7	8	12	13	15
2001	12.7	12.3	6.5	4.6	4.2	4.7			2.8	4.5	
2002	11.0	8.6	5.5	3.1	4.1	5.5	11.4	4.9	2.6	4.0	
2003	8.9	11.2	5.6	2.9	4.1	4.2	3.6	3.6	2.2	3.5	21.9
2004	6.4	8.7	5.7	3.0	3.5	3.6	7.4	3.8	2.7	3.9	20.3
2005	7.0	7.8	4.9	3.0	3.6	3.1	7.6	4.8	3.2	4.4	22.0
2006	7.5	7.3	5.6	3.2	3.8	3.4	9.4	3.5	3.8	5.3	21.0
2007	6.7	13.8	4.6	3.6	3.3	3.6	7.9	4.8	4.2	6.0	20.4
2008	7.2	11.4	4.4	3.0	3.9	4.1	5.5	3.9	3.5	6.0	19.3
2009	8.7	9.7	2.7	3.5	5.0	5.6	7.8	5.5	3.9	6.1	23.0
2010	7.1	10.3	5.3	3.0	5.6	5.3	5.6	3.5	4.1	8.3	22.3
2011	6.6	12.5	3.4	3.8	6.4	5.1	5.5	3.7	4.1	8.8	18.0
2012	7.9	10.4	4.4	4.1	6.0	4.5	6.8	4.1	3.7	7.3	18.3
2013	10.2	10.7	3.8	4.6	4.4	4.5	6.8	5.0	3.9	6.9	17.4
2014	10.4	10.3	3.4	4.0	4.1	4.7	5.5	3.9	2.2	7.3	3.9
Average [1]	8.3	10.4	4.8	3.5	4.5	4.4	7.1	4.3	3.4	5.8	20.3
Variation [2]	25%	0%	-29%	14%	-9%	7%	-23%	-9%	-36%	26%	-81%

[1] = 2001-2013 reference average, except for Area 15, where the 2003-2013 average was calculated.
[2] = Variation between the 2014 value and the reference average.

Table 5: Average size (mm) of whelk landed by fishing area from 2004 to 2014.

Year	Fishing Area										
	1	2	3	4	5	6	7	8	12	13	15
2004	73	72	87	87	81	81	82		85	70	82
2005	74	74		87	80	83	81	77	88	77	82
2006	77	71		83	80	87	84	76	85	80	83
2007	79	74		89	85	85	83	76	85	87	81
2008	78	72		89	85	83	87	71	88	83	88
2009	78	79		89	86	84	87	74	87	83	88
2010	79	82		90	89	88	87	75	88	87	85
2011	81	75		91	88	88	90	73	87	85	87
2012	80	78	92	95	90	89	90	74	89	85	83
2013	79	78		94	91	88	90	73	89	85	85
2014	78	82		95	88	88	86	75	90	84	93
Average [1]	78	76	89	89	85	86	86	74	87	82	84
Variation [2]	0%	8%		7%	3%	3%	0%	1%	4%	2%	10%

[1] = 2004-2013 reference average.
[2] = Variation between the 2014 value and the reference average.

Table 6: Proportion (%) of whelk smaller than the minimum legal size (70 mm) in commercial landings by fishing area from 2004 to 2014.

Year	Fishing Area										
	1	2	3	4	5	6	7	8	12	13	15
2004	38	43	2	6	14	13	9		11	48	8
2005	29	30		4	11	10	9	27	3	16	8
2006	19	41		14	15	3	4	26	4	9	4
2007	8	27		3	6	4	10	27	3	1	7
2008	15	43		3	4	6	5	40	2	6	2
2009	14	12		3	2	6	4	32	2	6	1
2010	12	6		2	2	2	7	27	3	2	2
2011	5	21		2	1	2	2	32	3	0.3	1
2012	7	10	0.3	0.1	1	2	1	32	3	1	3
2013	8	12		0.3	1	2	2	32			7
2014	10	2		0.2	4	2	3	19			1
2004-2013 Average	15	25	1	4	6	5	5	31	4	9	4

The average whelk density by size, area and year and the average density and weight of egg masses are presented in Table 7. In Forestville, the density of legal-sized (≥ 70 mm) whelk was higher in 2013 than previous years. The density measured in 2013 in Pointe-aux-Outardes and Baie-Comeau was similar to previous years. In 2011, the density of young whelk (≤ 50 mm) was over 5 individuals/100 m^2 in all areas; in 2013, such a density was found only in Forestville. The size of landed whelk has varied from 9 to 112 mm since the first surveys in 2005.

Whelk egg masses were also assessed as part of these surveys. Egg mass density is higher in Pointe-aux-Outardes and Baie-Comeau than Forestville (Table 7). In 2013, there were 0.01 masses/100 m^2 in Forestville, 1.5 masses/100 m^2 in Pointe-aux-Outardes and 1.6 masses/100 m^2 in Baie-Comeau.

Table 7: Average density of whelk by size class and average density and weight of egg masses by area and year obtained during research surveys.

Sector and year	Density (number/100 m^2 ± 95% confidence interval)			Average egg mass weight (g)
	≥ 20 mm	≥ 70 mm	Egg masses	
Forestville				
2005	6.6 ± 1.0	3.3 ± 0.5	0.02 ± 0.04	
2007	5.5 ± 0.8	2.4 ± 0.3		
2009	6.5 ± 1.1	1.9 ± 0.3	0.01 ± 0.01	51
2011	12.2 ± 2.1	2.9 ± 0.4	0.02 ± 0.01	222
2013	15.9 ± 2.5	5.6 ± 0.9	0.01 ± 0.01	133
Pointe-aux-Outardes				
2005	3.3 ± 1.6	1.9 ± 1.4	1.0 ± 0.7	
2007	4.2 ± 1.6	2.8 ± 1.1		
2009	4.7 ± 1.4	2.0 ± 0.1	1.1 ± 0.9	69
2011	12.0 ± 4.7	3.3 ± 1.3	1.4 ± 1.3	77
2013	6.8 ± 3.3	3.9 ± 2.0	1.5 ± 1.0	55
Baie-Comeau				
2005	42.7 ± 28.3	7.8 ± 7.2	1.5 ± 2.2	
2007	21.7 ± 9.2	6.4 ± 2.8		
2009	24.3 ± 12.3	6.0 ± 2.8	0.6 ± 0.4	72
2011	41.7 ± 18.2	16.4 ± 8.8	4.2 ± 4.2	130
2013	36.2 ± 28.7	17.9 ± 11.9	1.6 ± 1.4	136

Sources of Uncertainty

Because of the absence of independent indicators for almost all fishing areas, such as those from research surveys, the advice for whelk is entirely dependent on the quality of the data from logbooks and from sampling of the commercial catch. Data that are partial or do not reflect reality (e.g., a trap haul different from that registered in the logbook) would affect indicator values. Since in several areas whelk fishing is a complementary activity, the fishing effort sometimes varies during the season and from year to year. The arrival of less-experienced fishers or the departure of experienced fishers can also affect catch rates. Environmental conditions such as water temperature at fishing sites can also affect the performance of the fishery. Consequently, the actual status of the resource could be different from our interpretation, and recommendations may not be completely aligned with reality.

CONCLUSION

Whelk is a sedentary benthic species that attaches its eggs to the substrate during the egg-laying period. Development continues on the egg-laying site, and there is no pelagic larval stage to help disperse the young. These biological characteristics make whelk vulnerable to local overfishing. The conservation principles implemented for whelk are designed to protect the reproductive potential of each population, or in this case, of each fishing area.

The main commercial fishery management measures (minimum legal size, fishing season, limited number of licences issued and traps authorized, TAC in certain areas) were adopted with the goal of improving fishery management and avoiding overfishing this resource.

The harvest of sexually immature individuals can have negative impacts on the resource. It is therefore recommended not to harvest them. In light of recent information, this conservation measure is even more important, since it seems that a significant percentage of whelk over 90 mm are parasited and no longer contribute to the population's reproductive potential. In several areas, the current minimum legal size protects only some sexually immature whelk, since the size at which 50% of females are mature is often greater than 70 mm.

In the period from 2012 to 2014, stock status indicators (CPUE and size structure) showed a positive trend in Areas 1, 4 and 13, were stable in Areas 2, 5, 6 and 8 and decreased in Areas 3, 7, 12 and 15. In the special case of Area 7, where the fishery is focused on only a small area, it would be beneficial to explore and expand the fishing ground. In Areas 12 and 15, the 2014 CPUE was very low. The considerable drop in CPUE in Area 15 was not anticipated given the performance of the fishery in 2013 and could be related to the atypical environmental conditions in summer 2014.

In Areas 3, 4, 5, 8, 12 and 13, the number of traps used in 2014 was between 20 and 41% of the authorized number of traps under the current management measures. These various stocks may not be able to support latent effort, especially in areas that are already fished in entirety.

OTHER CONSIDERATIONS

The current selectivity of the traps does not permit the harvesting of only legal-size whelk. Consequently, sorting is done on board vessels. In order to limit incidental mortality of sublegal-size whelk, it is important that they be handled with care and released back into the water as soon as possible and at the site where they were fished. It is recommended that selective fishing gear and methods for handling sublegal-size whelk on board vessels be developed and used.

Care must be taken when it comes to fishing effort (in number of traps) being concentrated on a single vessel. It is important for the fishing effort in a given fishing area to be distributed across the entire available area to reduce the danger of local overfishing. For a few years, buddying up licences has been authorized in certain fishing areas to reduce operating costs. We need to ensure that these

licences are active and that the fishing areas visited are not restricted to those of only one of the fishers involved. Distribution of the effort throughout a fishing area should also be considered when authorizing the use of several licences for a single captain and vessel.

The gastropod *Neptunea* is a toxic species occasionally found in small numbers in whelk traps (Figure 3). It is therefore important to inform fishers about returning this gastropod to the water to avoid cases of intoxication.

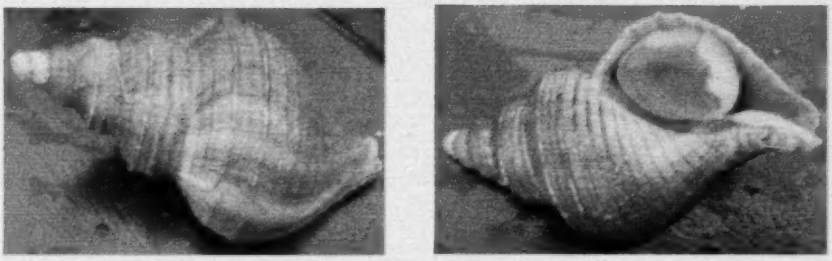

Figure 3: Photographs of Neptunea despecta (S. Le Breton 2011).

SOURCES OF INFORMATION

This science advisory report is from the March 10, 2015, meeting on the Assessment of the whelk fishery in the Quebec's inshore waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Galbraith, P.S., Chassé, J., Nicot, P., Caverhill, C., Gilbert, D., Pettigrew, B., Lefaivre, D., Brickman, D., Devine, L., and Lafleur, C. 2015. Physical oceanographic conditions in the Gulf of St. Lawrence in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/032. v + 81 p.

Gendron, L. 1992. Determination of the size at sexual maturity of the waved whelk *Buccinum undatum* Linnaeus, 1758, in the Gulf of St. Lawrence, as a basis for the establishment of a minimum catchable size. J. Shellfish Res. 11: 1–7.

Gendron, L. 1991. Gestion de l'exploitation du buccin *Buccinum undatum* au Québec : détermination d'une taille minimale de capture. Rapp. tech. can. sci. halieut. aquat. 1833: vii + 40 p.

Martel, A., Larrivée, D.H., and Himmelman, J.H. 1986. Behaviour and timings of copulation and egg-laying in the neogastropod *Buccinum undatum* L. J. Exp. Mar. Biol. Ecol. 96: 27–42.

Martel, A., Larrivée, D.H., Klein, K.R., and Himmelman, J.H. 1986. Reproductive cycle and seasonal feeding activity of the neogastropod *Buccinum undatum*. Mar. Biol. 92: 211–221.

Tétreault, F., Himmelman, J.H., and Measures, L. 2000. Impact of a castrating trematode, *Neophasis* sp., on the Common Whelk, Buccinum undatum, in the Northern Gulf of St. Lawrence. Biol. Bull. 198(2): 261–271.

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